端まで延ばし、器械を元の位置へ引き抜く。

アーム1と3が平行に配置されていることを特徴とする本発明の電気外科用器械（第8図、第9図）を用いて電気凝固を行う場合、（尖端6と7として形成されている）作用ジョーを相互に引き寄せると、尖端7は血管8に機械的圧力を加えることになる。次に、尖端7は、尖端6の両側をスライドする前に、行なおうとしている血管吻合位置の血管8内部から血液を移動させる。この例の場合、アーム1と3の作用ジョーはアーム自身に平行な縦方向へ移動する。

吻合する血管8の部分の必要な長さに応じて（これが長ければ長いほど血管8自身の太さは大きくなる）、中央尖端6はフォーク尖端7の間を通りすぎ、血管8と共に短かい距離ないし長い距離だけ引っぱられる。上記したように、吻合する血管の太さが大きければ大きいほど、吻合に必要な血管の無血部分はより長く、したがって、尖端6及びこれによってつかまれる血管8はより深く押込まれなければならない。上記した全てのステップは、平行に配置されたアーム1と3が与えられる時、この電気外科用器械によって簡単かつ容易に行うことができる。第14図から明らかなように、吻合する血管部分の長さは、単一尖端6によって2本の脚の尖端7形状のフォークの中に引き込まれる無血の血管部分に依存する。上記した長さは、中央尖端6からフォーク尖端7の一方への距離の2倍に相当する。

すでに上記したように、高周波電気によって対向する血管壁同士を確実に吻合できるのは、吻合する血管部分の内腔が無血のときのみである。したがって、約4ミリメータの太さの血管を確実に吻合するためには、無血部分の長さは6ミリメータでなければならず、血管の太さが8ミリメータであるとき、無血部分の長さは僅に10から12ミリメータの範囲になければならない、筈である。吻合する血管部分の長さは、適宜に広い範囲内で、術者の一方の手によって何ら他の補助器具ないし器械にたよることなく、容易にかつ確実に調節することができる。

中央尖端6がフォーク尖端7より長いと都合が良い。こうすると、本発明の電気外科用器械は手術するのにより簡単で容易になる。その理由は、必要な組織や露出した血管8を容易につかむことができるからである。

産業上の利用可能

したがって、同じ方向に曲がっている尖端の形状のこの器械の作用ジョーを設けることによって、組織内臓器部にあるいかなる太さの血管でも確実につかむことができ、吻合しようとする位置の露出血管内部から血液を有効に移動させることができる。また、太さの大きい血管を含むいかなる太さの切断血管の内腔を確実に吻合することができる。この場合、いわゆる「ハサミ効果」がないため、血管は機械的に損傷を受けないでいる。その上、切断血管の内腔は、どのような事前設定の長さでも、電気凝固死によって影響される組織を最少にし、かつ、血管を取りかこむ組織に対する機械的損傷を最少にして、吻合することができる。

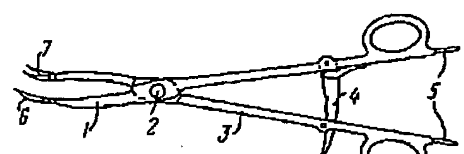


FIG.1

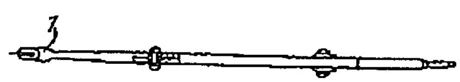


FIG.2

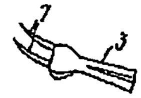


FIG.4

FIG.3

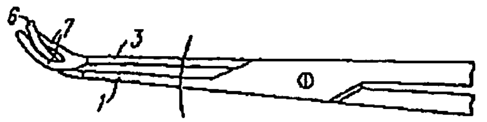


FIG.5

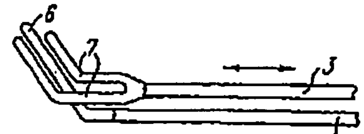


FIG.8

FIG.6

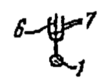
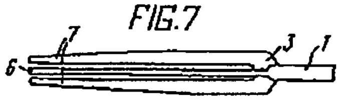


FIG.9

FIG.7



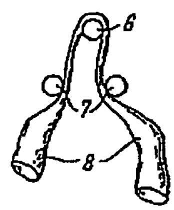


FIG.14

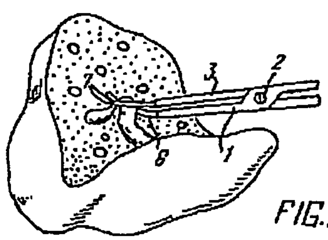


FIG.10

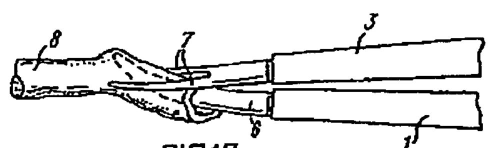


FIG.12

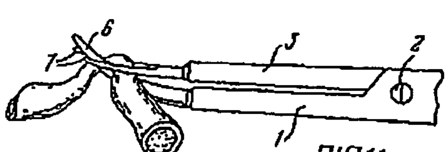


FIG.11

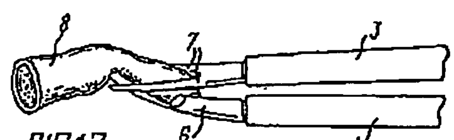


FIG.13

国際調査報告

International Application No PCT/SU 84/00001

I. CLASSIFICATION OF SUBJECT MATTER

IPC^4 A 61 B 17/[illegible]

II. FIELDS SEARCHED

Classification System	Classification Symbols
IPC^3	A 61 B 17/[illegible]

III. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of Document	Relevant to Claim No.
A	SU, A, 36[illegible] ([illegible]) 30 September [illegible] (30.09.[illegible])	[illegible]
A	SU, A, 401[illegible], ([illegible] INSTITUT), 25 November 1974 (25.11.74)	[illegible]

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
28 September 1984 (28.09.84)	11 October 1984 (11.10.84)
International Searching Authority: ISA/SU	Signature of Authorized Officer

KPA−016 日本·特開昭61−501068
Published Japanese translations of PCT international publication for patent applications (A)
No. 61-501068
[54] Title of Invention: Bipolar electrosurgical device
What is claimed is:
1. A bipolar electrosurgical device comprising arms having working jaws, which are conductive but insulated from each other, characterized in that the working jaws are formed as pointed ends (6 and 7) bending in the same direction, and the working jaw on the arm (3) is formed in the fork shape.
2. A bipolar electrosurgical device set forth in Claim 1 characterized in that the arms (1 and 3) are disposed in parallel to each other, and their working jaws mutually move in axial direction.
3. A bipolar electrosurgical device set forth in Claim 1 characterized in that the pointed end of one of the arms is longer than the fork-shaped jaw on the other arm (3).
4. A bipolar electrosurgical device set forth in Claim 1 characterized in that the surface area of one (6) of the pointed ends is equal to the total surface area of the fork-shaped pointed end (7).
5. A bipolar electrosurgical device set forth in Claim 1 characterized in that the surface area of one (6) of the pointed ends is smaller than the total surface area of the fork-shaped pointed end (7).
Specification
Technical Field
The present invention generally relates to medicine and specifically to a bipolar electrosurgical device.
The present invention may be widely used in anatomical surgeries, which have the greatest varieties concerning to human bodies, including electric incision of living tissues at wide frequency bands and high-frequency electrosurgeries. In accordance with the present invention, the bipolar electrosurgical device successfully performs surgeries as described below: that is, incision or excision of tissues, incision of thick-wall organs such as the stomach, intestines, and urinary bladders, and cutting and coagulation of blood vessels with different thickness using the electric incision techniques.
The bipolar electrosurgical device in accordance with the present invention presents the highest usefulness in use for bloodless surgeries of parenchmatous organs such as

the liver, spleen, and kidney and surgeries of blood vessels with greatest varieties of diameters.

Background technology

High-frequency electrosurgery is indispensable in performing the greatest number of surgeries in the general surgery, oncological surgery, neurosurgery, gastroenterology, urology, ophthalmology, and other many clinical medicines.

High-frequency electrosurgery is considered to be a method to apply surgical effect on body tissues of a patient using high-frequency current for the purpose of coagulation without incision. This method is based on physical and chemical processes underway in body tissues and is caused mainly by diathermy current effect.

The high-frequency electrosurgery has two types: monopolar and bipolar.

In the monopolar electrosurgery, one of the electrodes is active and causes the highest current density. This electrode is a working tool and the other (auxiliary) electrode is passive.

In bipolar electrosurgery, both electrodes are active and therefore used as working tools.

The most urgent subject in the surgery today lies in reliable, fast, and high-quality hemostasis of injuries of tissues and parenchmatous organs, in particular, such as liver, kidney, and spleen, and hemostasis of major blood vessels during surgical procedure planned in advance.

The publicly known technology includes various types of bipolar electrosurgical devices, and more specifically forceps and vessel coagulating forceps, in particular (Refer to advertisement brochure 'Surgical accessory ERBE for electrosurgery').

Respective devices mainly comprise mutually insulated two arms, each of which is equipped with conductive jaws for grasping a blood vessel and is supplied with high-frequency current. Such devices, however, cannot incise the atrophy of parenchmatous organs and reliably grasp the vessel located deeply in tissues. If further efforts are made to grasp the vessel, physical damage may be caused to the tissue in wider surrounding areas.

In addition, the hereinbefore-mentioned device forms an area whose tissues around the treated vessel have received great coagulation action, and coagulated tissues or thrombus adhered to the working surface of the device may be torn when the device is removed after coagulation.

In addition, the hereinbefore-mentioned device cannot simultaneously expose uncut vessels located deeply into a chunk of parenchmatous organs without bleeding and cannot mechanically grasp with high reliability.

Disclosure of Invention

The main and essential object of the present invention is to provide a bipolar electrosurgical device, which enables prompt and high-quality surgery of parenchmatous organs and blood vessels with different diameters.

The object may be attained

Brief Description of Drawings

The electrosurgical device in accordance with the present invention is described below in detailed description of particular embodiments for explanation to be interpreted in combination with the reference drawings.

Fig. 1 is an overall schematic diagram of the bipolar electrosurgical device in accordance with the present invention.

Fig. 2 is a plan view of the bipolar electrosurgical device of Fig. 1.

Fig. 3 is an explanatory view of the conductive working jaw on the other arm of the bipolar electrosurgical device in accordance with the present invention, which is formed as a single pointed end.

Fig. 4 is an explanatory view of the conductive working jaw on one of the arms of the bipolar electrosurgical device in accordance with the present invention, which is formed in fork shape.

Fig. 5 is an explanatory view of the conductive working jaw when the arms of the electrosurgical device in accordance with the present invention are closely positioned to each other.

Fig. 6 is a plan view of an embodiment of the device in accordance with the present invention, in which the conductive jaw is formed in a pointed shape, and the surface area of the pointed end is equal to that of the both pointed ends of the fork.

Fig. 7 is a plan view of an embodiment of the device in accordance with the present invention, in which the conductive jaw is formed in a pointed shape, and the surface area of the pointed end is smaller than that of the both pointed ends of the fork.

Fig. 8 is a schematic diagram of an embodiment of the electrosurgical device in accordance with the present invention characterized with the arms disposed in parallel.

Fig. 9 is a side view (from the pointed end) of the embodiment of the electrosurgical device in accordance with the present invention having arms disposed in parallel.

Fig. 10 is a schematic diagram of operation steps for electric coagulation, which is applied by the present invention to vessels, which is located at fissure of the injury deep in the living tissues and is not cut.

Fig. 11 is a schematic diagram of the operation steps for electric coagulation, which is applied by the present invention to moved and uncut vessels.

Fig. 12 is a schematic diagram of the operation steps for electric coagulation, which is applied by the present invention to (the interior and exterior of) cut vessels deep in the parenchmatous organ tissues.

Fig. 13 is a schematic diagram of the operation steps for electric coagulation, which is applied by the present invention to (the interior and exterior of) cut vessels deep in the parenchmatous organ tissues.

Fig. 14 is a schematic diagram of relative position of the pointed end of the device and vessel to be treated in the embodiment of the electrosurgical device with its arms disposed in parallel in accordance with the present invention.

Optimum Embodiments of Present Invention

The bipolar electrosurgical device in accordance with the present invention has electrically insulated conductive arms 1 (Figs. 1 and 2), which are connected to another electrically insulated conductive arm 3 with a pin 2. A restrictor 4 is provided on the arm to limit the opening angle of the device. Respective arms 1 and 3 are provided lead wires 5 for supplying high-frequency current. In the case shown in the figures, they are respectively provided with working jaws formed in the shape of pointed ends 6 and 7. The arm 1 ends in the pointed end 6 (Fig. 3), which is electrically insulated at the position where it comes to contact with the pointed end 7 of the other arm 3. The pointed end 7 of the arm 3 is bifurcated or has two pointed prongs (Fig. 4). When the arms 1 and 3 are brought into vicinity (Fig. 5), the pointed end 6 becomes engaged between the prongs of the pointed end 7. The pointed ends 6 and 7 are curved in the same direction. It is favorable that the curved pointed end 6 of the arm 1 is longer than the fork-shape pointed end 7 of the arm 3, and the surface area of the pointed end 6 (Fig. 6) may be equal to the surface are of the fork-shape pointed end

7. As known in the art, reliable coagulation of the blood vessel 8 and living tissues may be attainable only when the areas of the active electrodes (or pointed ends 6 and 7 in this particular embodiment) of the bipolar electrosurgical device are identical.
However, the surface area of the pointed end 6 may be smaller than the combined surface areas of the pointed end 7 (Fig. 7).
With the conductive working jaws of the electrodes thus constructed and arranged, incision may be made via the grasped tissue, since energy applied to the working jaws is proportionate to the inverse number of the surface area. In addition, tissues of hollow organs such as kidney or urinary bladder wall may be incised with the conductive jaws thus constructed.
The insulated arms 1 and 3 may be arranged in parallel to each other (Fig. 8). In such a case, the working jaws of the arms formed as pointed ends 6 and 7 may be axially moved in relative fashion (Fig. 9).
To understand the functions of the electrosurgical device in accordance with the present invention easily, the electric coagulation applied to uncut vessels in a fissure of an injury having received surgery is explained below for reference (Figs. 10 and 11). The procedure is conducted as described below.
The pointed end 6 of the arm 1 is used as a guide for mechanical free of an intact (uncut) vessel 8 in the injury having received surgery. Once the intact vessel 8 is freed, the pointed end 6 is placed in the position previously occupied by the vessel 8.
After the arms 1 and 3 are placed in the vicinity to each other and the freed vessel 8 is grasped with the pointed end 5 and fork 7, high-frequency current is applied to the lead wire 5. After the operation, the arms 1 and 3 are separated to the position of the restrictor 4, and the device is removed from the injury.
The bipolar electrosurgical device mentioned above may be used most effectively for coagulation of intact blood vessels with diameter of 0.2 or 0.3 mm to approx. 3 mm. The device causes mechanical and electrical coagulation injury around the target blood vessel but only in a limited area.
The typical procedure to coagulate interior/exterior of a cut blood vessel located deep in the parenchmatous organ tissue is now described (Fig. 12).
The procedure is conducted as described below.

The arms 1 and 3 are separated to the position of the restrictor 4 before the operation. The pointed end 6 is inserted into the lumen of the vessel with intermediate diameter. The bifurcated pointed ends 7 of the arm 3 are introduced into the liver parenchmatous tissue over the target blood vessel. The lumenal wall may be mechanically deformed by bringing the arms 1 and 3 in the vicinity and securely pressing the pointed ends 7 against the pointed end 6. Then high-frequency current is applied to the lead wire 5. After coagulation of the blood vessel, the arms 1 and 3 are separated to the position of the restrictor 4, and the device is removed from the injury to the original state. Since the pointed ends 6 and 7, when being in vicinity, form certain angle and positively intersect, the bipolar electrosurgical device may reliably grasp a severed end of the blood vessel 8 having the diameter of 0.2 or 0.3 mm to approx. 8 mm but cause trauma mainly on the liver, spleen, kidney and other living tissues.

The operation of the present electrosurgical device is explained by referring to electric vessel exterior/exterior coagulation of a cut blood vessel located deep in the parenchmatous organ tissue (Fig. 13). The arms 1 and 3 are separated to the position of the restrictor 4 before the operation. The pointed end 6 is then inserted into the vicinity of a bleeding blood vessel 8 with large internal diameter in the parenchmatous tissue, and the bifurcated pointed ends 7 of the arm 3 are introduced into the liver parenchmatous tissue over the blood vessel 8. The vessel 8 wall is securely pressed against the pointed ends 6 and 7 of the device by bringing the arms 1 and 3 in the vicinity to each other and bringing the grasped walls of the vessel 8 against each other. Then high-frequency current is applied to the lead wire 5. After the coagulation procedure, high-frequency current supply is turned off, the arms 1 and 3 are separated to the position of the restrictor 4, and the device is removed to the original position.

In electric coagulation using the electrosurgical device in accordance with the present invention characterized by parallel arrangement of the arms 1 and 3 (Figs. 8 and 9), the pointed ends 7 apply mechanical pressure on the blood vessel 8 when the working jaws (formed as the pointed ends 6 and 7) are pulled toward each other. When the pointed ends 7 move blood from interior of the blood vessel 8 at the position of vessel fused to be made while sliding

the both ends of the pointed end 6. In this case, the working jaws of the arms 1 and 3 moves along the axis parallel to the arms.
The center pointed end 6 passes between the pointed ends 7 according to required length of the fused blood vessel 8 (the blood vessel 8 becomes thicker with longer length), and is pulled with the blood vessel 8 for the length. As previously mentioned, thicker fused blood vessel lengthens the bloodless portion of the blood vessel required for fusion, the pointed end 6 and the blood vessel 8 grasped by the pointed end 6 shall therefore extend for a long distance. All the hereinbefore-mentioned steps may be simply and easily conducted with the electrosurgical device when the arms 1 and 3 arranged in parallel are provided. As obvious from Fig. 14, the length of fused vessel portion depends on the bloodless vessel portion taken into the fork in the shape of two pointed ends 7 by a single pointed end 6. Said length is equal to twice the distance between the center pointed end 6 and one of the forked pointed ends 7.
As already mentioned above, opposing blood vessels may be reliably fused only when the internal lumens of the vessels to be fused are bloodless. Therefore, the length of bloodless portion shall be 6 mm to fuse a blood vessel with diameter of approx. 4 mm, and it shall be approx. 10 to 12 mm when the diameter of the blood vessel is 8 mm. The length of the blood vessels to be fused shall be within adequately wide range and may be readily and reliably adjusted by a hand of the operator without any other assisting tools.
It is favorable that the center pointed end 6 is longer than the forked pointed ends 7, and the electrosurgical device of the present invention becomes more convenient and reliable in operation. This is because tissues and exposed vessel 8 may be readily grasped as required.
Industrial applications
Therefore, vessels of any size located deep in the parenchmatous tissues may be reliably grasped by providing working jaws of this device in the form of pointed ends curved in the same direction, and blood may be effectively moved from the exposed vessel interior at the position to be fused. In addition, the lumen of uncut vessels of any size including thick vessels may be reliably fused. In this case, the vessels receive no mechanical damage since there is no 'scissors action'. In addition, even when the lumen of the uncut vessels have

any length set in advance, the area receiving electric coagulation necrosis may be minimized, and mechanical damage to tissues surrounding the blood vessel may also be minimized for fusion.